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Research Article

PESTICIDAL PLANT SPECIES IMPACT ON WHIP SMUT REDUCTION AND SUGARCANE (*SACCHARUM OFFICINARUM* L.) PRODUCTION IN NIGERIA

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Abstract: Yield decline due to Whip smut is an issue that has plagued sugarcane production in Nigeria. The objective of the study was to evaluate the inhibitory effect of pesticidal plants at varying rates of application on whip smut disease for sugarcane genotypes production. Green house experiment was conducted in 2018 and 2019 at National Cereals Research Institute, Badeggi in the Southern Guinea Savanna ecology of Nigeria. The treatments consists of factorial combination of two sugarcane genotypes, B47419 and NCS 008, three plant extracts, (Moringa, Neem, Cassia) and three levels of application rates (40, 60, 80 g/l) arranged in a completely randomized design (CRD) replicated three times. The results showed that genotype B47419 suppressed *Sporisorium scitamineum* germination and penetration than NCS 008, and gave a higher growth and yield of sugarcane than NCS 008. Brix content was highest under B47419 than NCS 008. The application of Cassia plant extracts at the rate of 80 g suppressed *Sporisorium scitamineum* germination and penetration, produced higher growth and yield of sugarcane. In conclusion, application of Cassia plant extracts at 80 g was the best in managing *Sporisorium scitamineum*, effectively boast brix content and sustain the productivity of sugarcane in the study area and related ecologies.

Keywords: *Sporisorium scitamineum*, sugarcane disease, pesticidal plants, whip smut.

Introduction

Sugarcane (*Saccharum officinarum* L.) is a significant commercial cash crop widely grown by farmers in most tropical countries grown for the production of sugar, molasses, livestock feeds, alcohol, bagasse for fuel [BASSEY & al. 2021], and trash for mulching and as organic fertilizer [BASSEY & al. 2022]. Sugarcane contributes 60% of the total world sugar requirement, while the remaining 40% comes from sugar beet [BASSEY & al. 2023]. Whip smut (*Sporisorium scitamineum*) of sugarcane is the most serious and widely spread disease of sugarcane and causes a significant reduction in cane quantity and quality [WADA & ANASO, 2016; RAJPUT & al. 2021]. The severity of this disease often depends on the pathogen races, environmental conditions, cultivar genotype and the interaction among these three factors.

In addition biotic factors especially diseases effects limit optimum sugar cane yield [BASSEY & WADA, 2024]. Reduction in yield components and cane yield losses due to whip smut disease has been reported by WADA (2018). Besides, in this agroecology in Nigeria, the common sugar cane types under production are the chewing cane for human consumption and commercial cane as raw materials for the sugar and sugar-related industries. One potential way

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to manage smut incidence and improve sugarcane production among small land holders to meet the demand for sugar is by the use of pesticidal plant species.

There is an urgent need to investigate pesticidal plants as options to safe and boost the production of sugarcane genotypes in order to meet the needs of increasing population. Hence, the objective of the study was to evaluate the inhibitory effect of pesticidal plants at varying application rates on whip smut disease for sugarcane genotypes production in this study area.

Materials and methods

Green house trial was conducted at the sugarcane experimental screen house of the National Cereals Research Institute, Badeggi (latitude 9°45′ N, longitude 0.6°07′ E) in the Southern Guinea savanna agro-ecological zone of Nigeria in 2018 and 2019 rainy season.

At the commencement of the experiment, fresh smut whips were collected in the early hours of the day between 6.30-7.30 a.m. following the method of NASR (1977) and modified by WADA (2005). They were dried for one hour under the shade, scrubbed with hands covered with sterile gloves to obtain smut teliospores. The teliospores were sieved using a mesh. Ten grams (10 g) of the sieved teliospores were weighed and sealed in cellophane bags and stored in the refrigerator in the laboratory for inoculation process at a later date.

The smut teliospore suspension was prepared by adding one liter of sterilized distilled water which was subsequently emptied into 25 liters of sterilized water and stirred vigorously to obtain a homogenous suspension of the teliospores. The suspension aseptically inoculated on 3-budded sugar cane sets for 1 hour. They were then removed and incubated overnight in wet sterile jute for 14 hrs and subsequently planted out in the green house for further investigations.

Fresh leaves of *Azadirachta indica* (neem), *Moringa oleifera*, *Senna alata* (syn. *Cassia alata*) were washed with tap water and then with distilled water weighed (100 g) before grinding into paste with piston and mortar. The paste obtained were used to prepare three concentrations 40 g/l, 60 g/l and 80 g/l. The plant extracts were prepared by soaking the earlier prepared *Azadirachta indica* (neem), *Moringa oleifera*, *Cassia alata* leaves powder in sterile water overnight.

The inoculated cane cuttings were immersed in each of the extract [WADA, 2005].

The total rainfall during the experimental period was 1500.5 mm in 2018 and 1015.8 mm in 2019, respectively. The mean air temperature during the sugarcane plant cropping season was 33 to 34 °C in 2018 and 33 to 36 °C in 2019 plant cropping seasons (Table 1).

The treatments consists of factorial combination of two sugarcane genotypes, B47419 and NCS008, three plant extracts (Moringa, Neem, Cassia) and three levels of application rates (40, 60, 80 g/l) arranged in a completely randomized design (CRD) replicated three times. Tender healthy young stalks of six months old sugarcane were used as planting material. The stalks were cut into setts each containing three eye buds and planted in pots filled with soil. Agronomic practices from fertilizer application, weeding and watering were carried out at the required growth stages of the sugarcane until termination of the experiment. Weeding was done by hand pulling one week before the application of fertilizer. Irrigation was done twice a week.

All data collected were subjected to analysis of variance (ANOVA). The means were separated using Duncan multiple range test at 5% level of probability using SAS version 9.0 statistical package.

Results and discussions

Smut incidence at three months after planting (MAP) was significantly ($p<0.01$) observed on NCS008 than B47419 in 2018 season. There was no difference found in plant extracts used. Application rate of 80 g/l obtained the lowest smut incidence than the lower rates. There was no interaction between the treatment combinations on smut incidence at 3MAP in 2018 (Table 2). In 2019, smut incidence was lowest on B47419. *Moringa* plant extract significantly ($p<0.01$) had the least incidence at 3 MAP. Application rate of 80 g/l produced the least incidence of smut than the lower rates tested. There was no interaction between the treatment combination tested on smut incident in 2019 (Table 2). Smut incidence at 6 MAP was significantly affected by varieties in 2018. Plant extract had no effect on smut incident at 6 MAP. Application of 80 g/l of extract had the least incidence of smut compared to the lower rates (Table 2). In 2019, there was no significant effect of varieties on smut incident at 6 MAP. *Moringa* plant extract produced the least incident than the other extract tested. Application of 60 g/l of extract produced the least smut incident (Table 2). The superiority of B47419 in having lower Smut disease incidence than NCS008 can be attributed to the differences in the genetic makeup, fast establishment, higher tillering ability and quick canopy formation of the variety which was influenced by adequate rainfall and temperature. This result is in accordance with those of BASHIR & al. (2012) and FIGUEROA-RODRÍGUEZ & al. (2019) who reported that significant difference exist among Smut incidence of sugarcane genotypes due to genetic makeup and conductive environment.

Table 1. Temperature and rainfall distribution from 2018 to 2019 cropping season at Badeggi

Months	**Temperature (˚C)**		**Rainfall (mm)**	
	2018	**2019**	**2018**	**2019**
January	36	35	0.0	0.0
February	38	37	0.0	0.0
March	39	40	95.4	4.0
April	40	39	18.7	4.5
May	36	34	220.6	274.9
June	32	35	286.8	146.4
July	31	32	346.1	161.8
August	31	31	203.8	251.7
September	30	30	273.5	202.1
October	33	32	59.2	28.2
November	34	35	0.0	0.0
December	35	33	0.0	0.0
Total	415	375	1504.1	1073.6

Source: Weather station, National Cereals Research Institute Badeggi.

Table 2. Effects of sugarcane genotypes, plant extracts and application rates on Smut disease incidence at 3 and 6 MAP in 2018 and 2019 seasons

Treatments	Whip Smut incidence			
	3 MAP		6 MAP	
	2018	2019	2018	2019
Genotypes (S)				
B47419	2.78	4.65	3.00	4.50
NCS008	4.61	5.15	3.00	4.22
LSD (0.05)	0.71	0.4	0.41	0.5
Extract (E)				
Moringa	3.69	4.17	3.00	2.92
Neem	3.69	5.03	3.00	5.42
Cassia	3.69	5.50	3.00	4.75
LSD (0.05)	0.81	0.5	0.41	0.6
Rates (R)				
40	3.83	5.33	3.25	4.92
60	3.52	4.81	2.92	4.53
80	3.43	4.56	2.83	3.83
LSD (0.05)	0.81	0.5	0.48	0.7
Interaction	NS	NS	NS	NS

LSD – least significant difference, NS – not significant, MAP – months after planting

Sugarcane stalk height at 6 MAP was significantly affected by varieties in 2018 (Table 3). NCS008 significantly produced higher stalks than B47419 in 2018 season. The application rate of 80 g/l had more stalk than the lower rate applied (Table 3). The interaction between varieties, plant extract, solvent and rate was not significant in 2018. In 2019 season, varieties had no effect on stalk high at 6 MAP. Similarly, Cassia plant extract significantly had higher stalks than the other extract tested. The application rate of 80 g/l had more stalk than the lower rate applied (Table 3). The interaction between varieties, plant extract, solvent and rate of application on stalk height was not significant in 2019 (Table 3). The production of consistently taller sugarcane plant and stalk in plots with NCS008 can be attributed to their erect stools at maturity, exhibition of heavy stool habit influenced by good environmental conditions, efficient moisture use, better weed competitiveness, tolerant to drought and variation in the leaf architecture. This finding is also in agreement with the findings of CHEEMA & al. (2010) who reported that, industrial sugarcane establishes faster because of its ability to withstand drought and diseases, this in turn translated into faster growth and development.

The effect of varieties, plant extract and rate of application on stalk girth at 6 MAP in 2018 season was not significant. Also, the interaction between the treatments on stalk girth at 6 MAP was not significant (Table 3). Significant effect was found in 2019 on stalk girth at 6 MAP. NCS 008 was significantly (P<0.01) higher than B47419. Furthermore, Cassia plant extract produced thicker stalk than the other extract tested in 2019 (Table 3). The rate of application 80 g/l significantly (P<0.01) produced thicker stalk than the lower rates. There was no significant effect on the interaction among the treatments on stalk girth at 6 MAP in 2019 (Table 3). The superiority of NCS008 in having bigger stalk girth than B47419 can be attributed to low stool habit, more robust and soft stem with high water and less sucrose content impacted by favorable rainfall and temperature. This confirms the finding of AHMED & al. (2014) who reported that, local canes has more robust, soft stem with high water and less sucrose content than the industrial canes.

Brix content at 8 MAP was significantly affected by varieties such that NCS008 had higher brix than B47419 in 2018. There was no difference among the plant extract tested. Furthermore, application rate of 80 g/l significantly produced higher Brix content than the lower rates at 8 MAP in 2018. In 2019, brix content at 8 MAP was higher in NCS008. Cassia plant extract significantly had higher brix than other extract tested. The application rate of 80 g/l produced higher brix than the lower rate tested. There was no interaction between the treatments (Table 3). The higher brix content observed in the genotype NCS 008 compared with the B47419 could be attributed to growth habit affected by beneficial environmental conditions, efficient use of applied inputs, better competitive ability to suppress weeds and tolerance to drought. This is in agreement to the findings of AHMED & al. (2014), HASSAN & al. (2017) and FIGUEROA-RODRÍGUEZ & al. (2019) who reported that, improved sugarcane (industrial canes) genotypes have thin stems with high sucrose content and less water due to the varied morphological differences that exist among the genotypes.

B47419 significantly produced more single stalk weight (SSW) than NCS008 in 2018. There was no significant difference among the plant extract used. SSW was higher when 80 g/l application rate was used than the other lower rates (Table 3). There was no interaction between the treatment combinations on SSW in 2018 season. In 2019, SSW was higher in NCS008 than B47419. Cassia plant extract performed better than other plant extracts used. Similarly, application of 80 g/l produced more SSW than the lower rates. There was no interaction between the treatment combinations on SSW in 2019 season (Table 3). Cane yield of NCS008 was significantly ($P<0.01$) higher than B47419 in 2018 season. There was no difference among the plant extract used on cane yield in 2018. The application rate of 80 g/l produced more cane yield than the lower rates tested (Table 3). In 2019, the yield of NCS008 was higher than that of B47419. Similarly, Cassia plant extract had more yield than the other extracts tested. The 80g application rate produced more cane yield than the other lower rate used (Table 3). Cassia plant extract in combination with application rate of 40-80 g/l consistently produced higher cane yield in 2018 season.

In 2019 season, cane yield was higher in combination with Neem/Cassia extract at 80 g/l rate of application (Table 3). The higher sugarcane yield of NCS 008 than that of B47419 in each year of this study could be due to its genetic make up, fast establishment influenced by favourable environmental conditions (Rainfall and temperature), higher tillering ability, quick canopy formation, heavy residue production, heavy stooling ability and better weed competitive ability, which was more efficient in exploiting growth contributing factors than B47419. This result is in accordance with those of BASHIR & al. (2012) and FIGUEROA-RODRÍGUEZ & al. (2019) who reported that significant difference exist among cane yield of sugarcane genotypes due to genetic makeup and good environmental conditions.

Table 3. Effects of sugarcane genotypes, plant extracts and application rates on Stalk height, Girth, Brix content, Single stalk weight and Cane yield at harvest in 2018 and 2019 seasons

Treatment	Stalk height (cm)		Stalk girth (cm)		Brix content (%)		Single stalk weight		Cane yield (t ha^{-1})	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Genotypes (S)										
B47419	111.1	124.3	1.21	1.33	17.04	18.02	0.73	0.95	19.35	22.08
NCS008	137.2	123.3	1.47	1.44	19.02	18.98	1.19	1.19	32.39	26.04
LSD (0.05)	7.6	4.1	0.86	0.1	0.49	0.1	0.6	0.1	1.25	0.95
Extract (E)										
Moringa	124.1	102.8	1.34	1.20	18.03	17.29	0.96	0.67	25.87	17.97
Neem	124.2	128.4	1.34	1.40	18.03	18.00	0.96	1.04	25.87	24.25
Cassia	124.1	140.1	1.34	1.54	18.03	20.21	0.96	1.32	25.87	29.96
LSD (0.05)	9.4	6.1	0.11	0.1	0.6	0.1	0.8	0.1	1.5	1.17
Rates (R)										
40	107.0	121.7	1.30	1.34	17.64	18.36	0.80	0.92	23.26	22.88
60	125.4	125.0	1.26	1.38	17.44	18.46	0.97	1.03	26.91	24.34
80	139.9	124.3	1.46	1.42	19.02	18.68	1.12	1.08	27.45	24.95
LSD (0.05)	9.4	5.0	0.11	0.1	0.6	0.1	0.82	0.1	1.52	1.17
Interaction										
S x W	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

LSD – least significant difference, NS – not significant.

Conclusion

Application of Cassia plant extracts at 80 g was the best in managing *Sporisorium scitamineum*, effectively boast brix content and sustain the productivity of sugarcane in the study area and related ecologies.

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